RI 8855

Bureau of Mines Report of Investigations/1984

Hand Dismantling and Shredding of Japanese Automobiles To Determine Material Contents and Metal Recoveries

By J. W. Sterner, D. K. Steele, and M. B. Shirts

UNITED STATES DEPARTMENT OF THE INTERIOR

Report of Investigations 8855

Hand Dismantling and Shredding of Japanese Automobiles To Determine Material Contents and Metal Recoveries

By J. W. Sterner, D. K. Steele, and M. B. Shirts

UNITED STATES DEPARTMENT OF THE INTERIOR
William P. Clark, Secretary

BUREAU OF MINES
Robert C. Horton, Director

Library of Congress Cataloging in Publication Data:

Sterner, J. W. (Joseph W.)

Hand dismantling and shredding of Japanese automobiles to determine material contents and metal recoveries.

(Report of investigations / United States Department of the Interior, Bureau of Mines ; 8855)

Bibliography: p. 25.

Supt. of Docs. no.: I 28.23:8855.

1. Automobiles--Materials. 2. Scrap metals. I. Steele, D. K. (Donald K.). II. Shirts, M. B. (Monte B.). III. Title. IV. Series: Report of investigations (United States. Bureau of Mines) ; 8855.

TN23.U43 [TL154] 622s [669'.042] 83-25199

CONTENTS

ILLUSTRATIONS

TABLES

TABLES--Continued

UNIT OF MEASURE ABBREVIATIONS USED IN THIS REPORT

°C	degree Celsius	lb	pound
cm^3	cubic centimeter	min	minute
in	inch	pct	percent

HAND DISMANTLING AND SHREDDING OF JAPANESE AUTOMOBILES TO DETERMINE MATERIAL CONTENTS AND METAL RECOVERIES

By J. W. Sterner,[1] D. K. Steele,[2] and M. B. Shirts[3]

ABSTRACT

The Bureau of Mines conducted studies on four makes of Japanese automobiles, three 1981 and one 1982 model years, received from three manufacturers to determine if their materials composition would present problems to the current technology used to process junk automobiles for metal recovery. One of each make of automobile was hand-dismantled to determine the materials composition. In addition, two nearly identical automobiles of each make were shredded at a commercial operation where all metal products and rejects were collected for analysis to determine metal and nonmetal distribution. The average weight of the four automobiles to be dismantled, less batteries, tools, and fluids, was 1,938.3 lb. The weight was distributed as 1,472.9 lb ferrous and 115.6 lb nonferrous metals, 275.2 lb combustibles, 72.3 lb noncombustibles, and 2.3 lb electrical components. The dismantled automobiles, less gas tanks, fluids, tools, wheels, tires, and batteries, which were all removed from the automobiles that were shredded, contained an average of 1,389.1 lb ferrous and 101.6 lb nonferrous metals, 305.7 lb nonmetals, and 2.3 lb electrical components. In comparison, materials collected from the shredded automobiles averaged 1,304 lb ferrous metals, 80 lb nonferrous metals, and 341 lb landfill materials. There were no materials used in the manufacture of the late model Japanese automobiles that should present handling or processing problems to the steelmaking or secondary metal recyclers.

[1]Group supervisor.
[2]Metallurgist.
[3]Research supervisor.
Salt Lake City Research Center, Bureau of Mines, Salt Lake City, UT.

INTRODUCTION

Since the energy shortage crisis in the mid-1970's the popularity of smaller, fuel-efficient automobiles has resulted in downsizing, redesigning, and substitution of lighter weight materials in both domestic and foreign automobiles. Newly developed nonferrous metal alloys and high-strength low-alloy (HSLA) steels are being used to reduce automobile weights. The use of plastics also continues to increase.

Foreign automobile manufacturers, already producing compact and subcompact automobiles, quickly increased their exports to the United States, where most auto production was geared to larger cars. Expansion of existing technology was easier, less costly, and quicker for foreign automobile manufacturers to accomplish than was this country's retooling and redesigning of automobile production facilities. Today, Japanese imported automobiles account for approximately one-third of domestic new car sales (1).[4]

The changing automobile size and materials content potentially could affect the capability and technology of the automobile scrap processors. Junked automobile ferrous and nonferrous metals are a major scrap source for steel and secondary metal industries. The smaller automobiles contain less ferrous metals but as much or more nonferrous metals and nonmetals than most automobiles being junked today. Automobile shredders presently process 80 to 90 pct of the junked automobiles for metal recycling. These shredders tear and cut an automobile into fist-sized or smaller chunks in less than a minute. Ferrous metals are recovered by magnetic separation; nonmagnetic metals are recovered by air classification or water elutriation (2-3). Nonmetal rejects are used as landfill.

In 1969, the Bureau of Mines completed research to determine the average composition of a typical automobile to determine the potential quantities of recoverable metals and nonmetals. A detailed hand-dismantled material classification was conducted on 15 junked automobiles (4) and showed that the circa 1960 "full-size" automobile contained, in pounds:

Ferrous metals	3,043.3
Nonferrous metals	157.1
Rubber and combustibles	172.2
Glass and noncombustibles	102.0
Total	3,574.6

The nonferrous metals included 20.4 lb battery lead.

The Bureau of Mines obtained four makes of 1981 and 1982 Japanese manufactured automobiles (fig. 1) to determine their materials content and if any of the materials used would present potential recycling problems. A three-phase study was conducted to--

1. Determine material composition of Japanese-imported automobiles by hand dismantling and categorizing.

2. Shred nearly identical model automobiles from each manufacturer to determine shredded component distribution.

3. Compare known metal contents of hand-dismantled automobiles with metals recovered from shredding.

The automobiles used in the study included three each of the following:

1981 Honda Accord	1981 Datsun 210
1981 Toyota Tercel	1982 Nissan Sentra

[4]Underlined numbers in parentheses refer to items in the list of references at the end of this report.

FIGURE 1. - 1981 Honda Accord, 1981 Toyota Tercel, 1981 Datsun 210, and 1982 Nissan Sentra automobiles donated for the study.

ACKNOWLEDGMENTS

The Bureau of Mines gratefully acknowledges donations made by the American Honda Motor Co., Inc., for three new 1981 Honda Accord automobiles, Toyota Motor Sales USA, Inc., for three new 1981 Toyota Tercel automobiles, and Nissan Motor Corp. in USA for three new 1981 Datsun 210 automobiles and three new 1982 Nissan Sentra automobiles used in the study. In addition, the Hugo Neu Steel Co., Salt Lake City, UT, shredded eight of the automobiles and assisted in collecting all products and rejects for analysis. The cooperation of these companies made this study possible.

PROCEDURES

HAND DISMANTLING

The automobiles to be dismantled were weighed, then systematically dismantled using common handtools plus air and electric-powered hammers, wrenches, chisels, and screwdrivers. Infrequently, an acetylene cutting torch was required for bimetal separations.

Each area of the automobile--interior, exterior, body, engine, and transmission--was systematically dismantled (fig. 2). Identification of components, materials, location, and weight data were continuously recorded during the progress of the work. Electronic components were removed from the automobiles as complete units, and weight data were obtained before they were forwarded to the Bureau's Avondale Research Center for determining the precious metal content. After dismantling, material balances were obtained. All materials were categorically displayed, identified, and photographed (figs. 3-6). Each automobile was dismantled and categorized completely before progressing to the next one to avoid material loss or mixup.

The automobile compositions were calculated excluding batteries, fluids, and tools. A second composition was also calculated which excluded batteries, fluids, tools, gasoline tanks, wheels, and tires to represent the automobiles as they would be shredded.

SHREDDING

Automobile weights were obtained at the shredding site both before and after preparation for shredding. Preparation included removing the gasoline tanks (fig. 7), batteries, tires, and wheels. The shredding mill, transfer conveyors, dust collection systems, and processing classifiers were purged before shredding the test automobiles to remove residual metals and nonmetals hung up or trapped in the system during production operation. Paired automobiles were fed into the shredder (fig. 8), one behind the other. Two metal products and six reject stream discards were collected in containers, weighed, and taken to the Bureau

FIGURE 2. - Dismantling the 1981 Honda Accord.

KEY

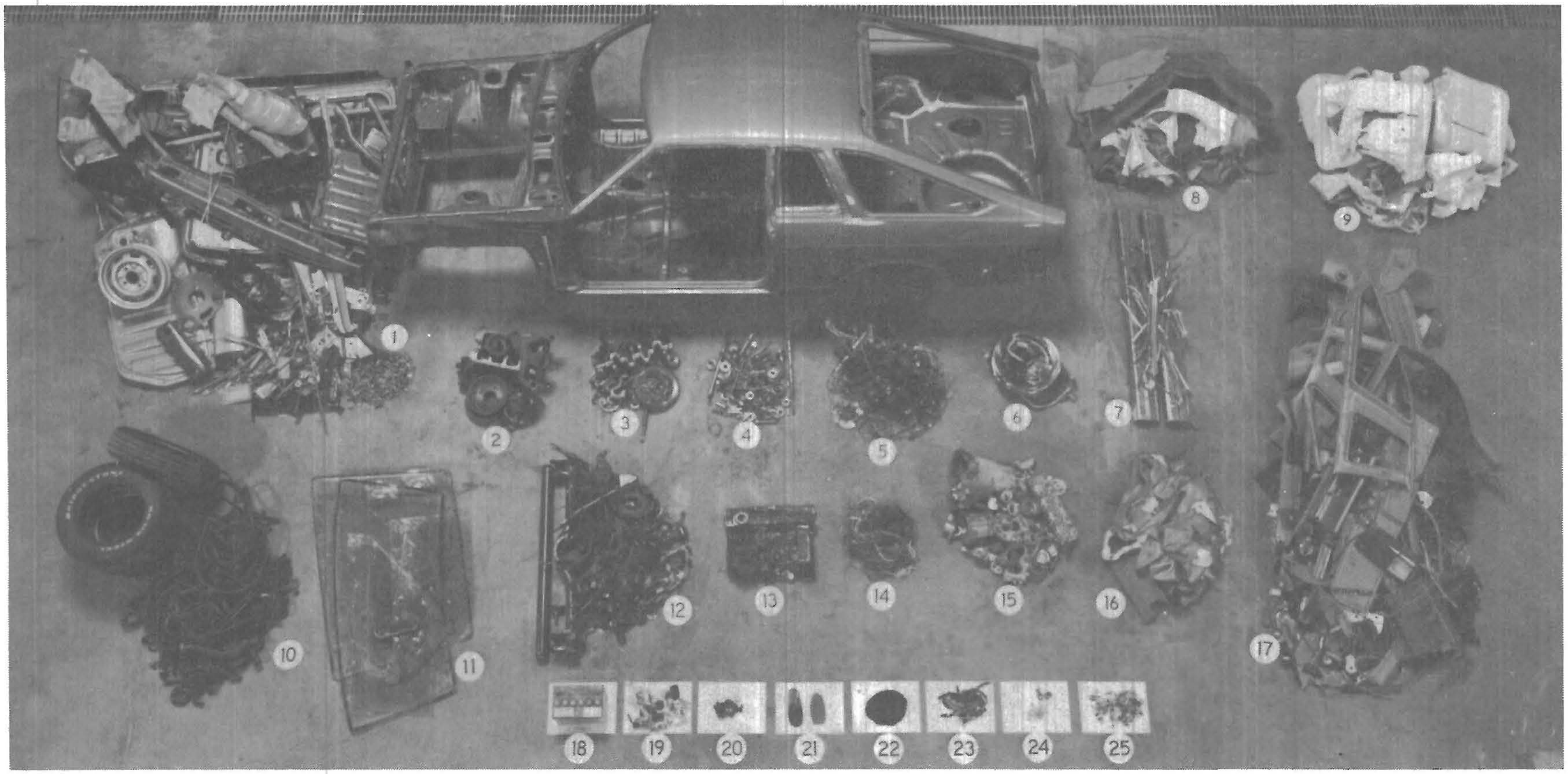
1. Light iron
2. Glass
3. Rubber
4. Vinyl
5. Combustibles
6. Aluminum
7. Catalytic converter
8. Zinc
9. Coated copper wire
10. Lead
11. Battery
12. Brass
13. Charcoal
14. Circuit boards
15. Stainless steel
16. Forged steel
17. Cast iron
18. Heavy iron
19. Chrome-plated steel
20. Hardened steel
21. Cast steel
22. Spring steel
23. Polyurethane foam
24. Plastic

FIGURE 3. - Dismantled and categorized 1981 Honda Accord.

KEY

1. Light iron
2. Rubber
3. Glass
4. Cast iron
5. Cast steel
6. Heavy iron
7. Chrome-plated steel
8. Hardened steel
9. Stainless steel
10. Copper and brass
11. Coated copper wire
12. Vinyl
13. Spring steel
14. Aluminum
15. Polyurethane foam
16. Combustibles
17. Plastics
18. Battery
19. Zinc
20. Lead
21. Asbestos
22. Carbon
23. Ceramic (catalytic converter)
24. Ceramic

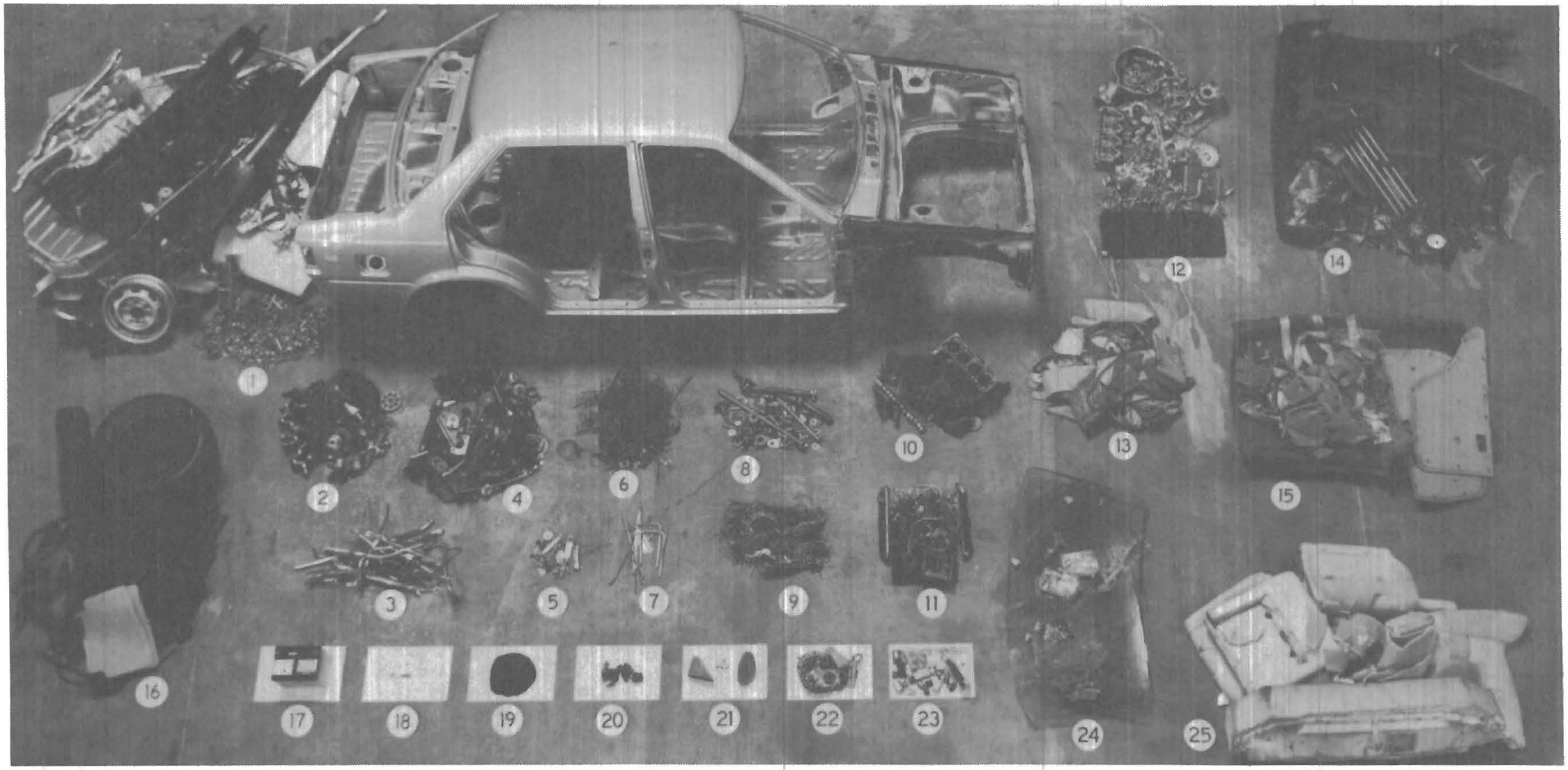
FIGURE 4. - Dismantled and categorized 1981 Toyota Tercel.



KEY

1. Light iron
2. Cast iron
3. Cast steel
4. Hardened steel
5. Spring steel
6. Stainless steel
7. Chrome-plated steel
8. Combustibles
9. Polyurethane foam
10. Rubber
11. Glass
12. Heavy iron
13. Brass and copper
14. Coated copper wire
15. Aluminum
16. Vinyl
17. Plastic
18. Battery
19. Electrical components
20. Ceramic
21. Ceramic (catalytic converter)
22. Carbon
23. Asbestos
24. Lead
25. Zinc

FIGURE 5. - Dismantled and categorized 1981 Datsun 210.



KEY

1. Light iron
2. Cast steel
3. Stainless steel
4. Heavy iron
5. Zinc
6. Spring steel
7. Chrome-plated steel
8. Hardened steel
9. Coated copper wire
10. Cast iron
11. Copper and brass
12. Aluminum
13. Vinyl
14. Plastic
15. Combustibles
16. Rubber
17. Battery
18. Lead
19. Carbon
20. Ceramic magnetic
21. Ceramic
22. Asbestos
23. Electrical components
24. Glass
25. Polyurethane foam

FIGURE 6. - Dismantled and categorized 1982 Nissan Sentra.

FIGURE 7. - Removing gas tank of 1981 Toyota Tercel prior to shredding.

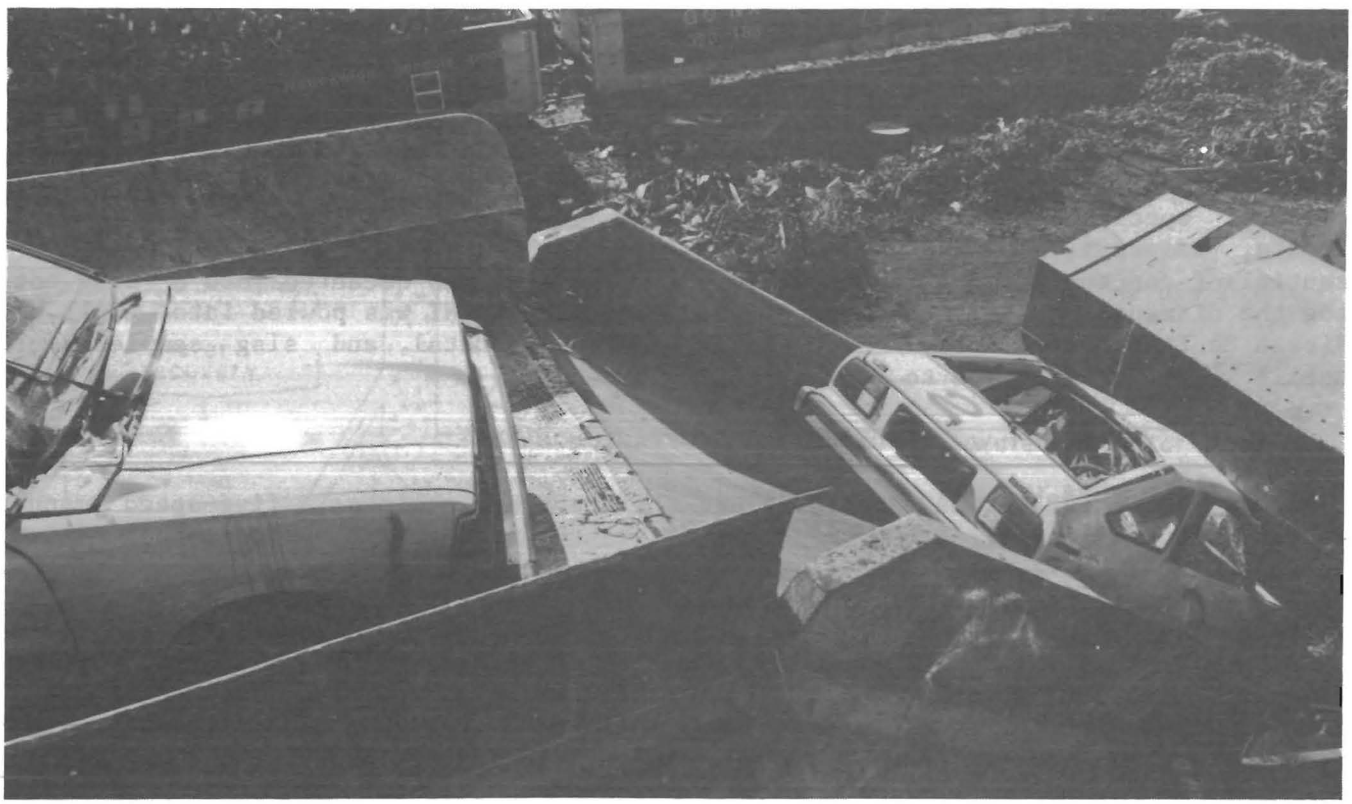


FIGURE 8. - Shredding 1981 Datsun 210's.

of Mines for analysis. Products and rejects were dried, if required, and hand-picked to separate metals and nonmetals into categories. Two or more different metals, physically attached, that could not be readily separated were classified with the major metal.

All tires and batteries were disposed of in accordance to donors' stipulations.

A schematic of the shredder operation is presented in figure 9. The collection sites for all products and rejects are highlighted.

HIGH-STRENGTH LOW-ALLOY STEEL MELTING TEST

The 1982 Nissan Sentra is the only automobile in the completed study to contain HSLA steel in significant quantities as shown in figure 10. HSLA steel is used to reduce the weight of the automobile as well as increase the strength of the structural supports.

There is concern among some U.S. foundries that the alloys in HSLA steels from shredded automobile scrap could detrimentally affect ferrous scrap metal processing or the quality of the iron products. There is also the realization that a separated HSLA steel scrap could be a premium product for recycling. For these reasons, special attention was taken to locate, identify, and determine the potential of concentrating HSLA steel during the dismantling and shredding of the Nissan Sentra automobiles. Each automobile contains from 186 to 206 lb HSLA steel. Detailed locations of the HSLA steels contained in the automobiles were provided by the Nissan Motor Corp.

The entire ferrous product from one shredded Sentra was melted in the Bureau's Albany Research Center furnace to determine if the HSLA steel additions would adversely affect recycling of scrap steel.

The melting test was conducted in a three-phase ac, 1-ton-capacity, tiltable electric arc furnace. The furnace was filled with 1,197 lb magnetic metal scrap product from the Sentra; nonmetals physically attached to the ferrous product such as rubber, plastic, and upholstery were first removed by hand picking. The metal scrap was then melted down in the furnace. The melt was sampled and analyzed using a direct reading spectrograph.

Subsequently, 49.3 lb quartz and 51.5 lb limestone were added to the melt and rabbled to form a suitable slag. Then 5 lb FeMn was added to determine if the carbon and manganese levels could be increased. The melt was again sampled and analyzed.

The bath temperature was then increased from 1,540° to 1,618° C, to increase fluidity, and the furnace contents were tapped into a 1-ton-capacity ladle.

The slag was decanted into a slag pot, and the metal was poured into 60-lb pig molds. Metal and slag samples were taken.

DESCRIPTION OF AUTOMOBILES

Honda.--Three 1981 Honda Accord deluxe models; four-cylinder, 1,600-cm^3 transverse engines; five-speed manual transmissions with front-wheel drive, equipped with power steering.

Toyota.--Two 1981 Toyota Corolla Tercel models, including standard and deluxe two-door sedans; four-cylinder, 1,500-cm^3 transverse engines; five-speed manual transmissions with front-wheel drive, equipped with power steering.

One 1981 Toyota Corolla Tercel SR5 with a four-cylinder, 1,600-cm^3 transverse engine and five-speed transmission. Deluxe model with sunroof, air conditioning and power steering.

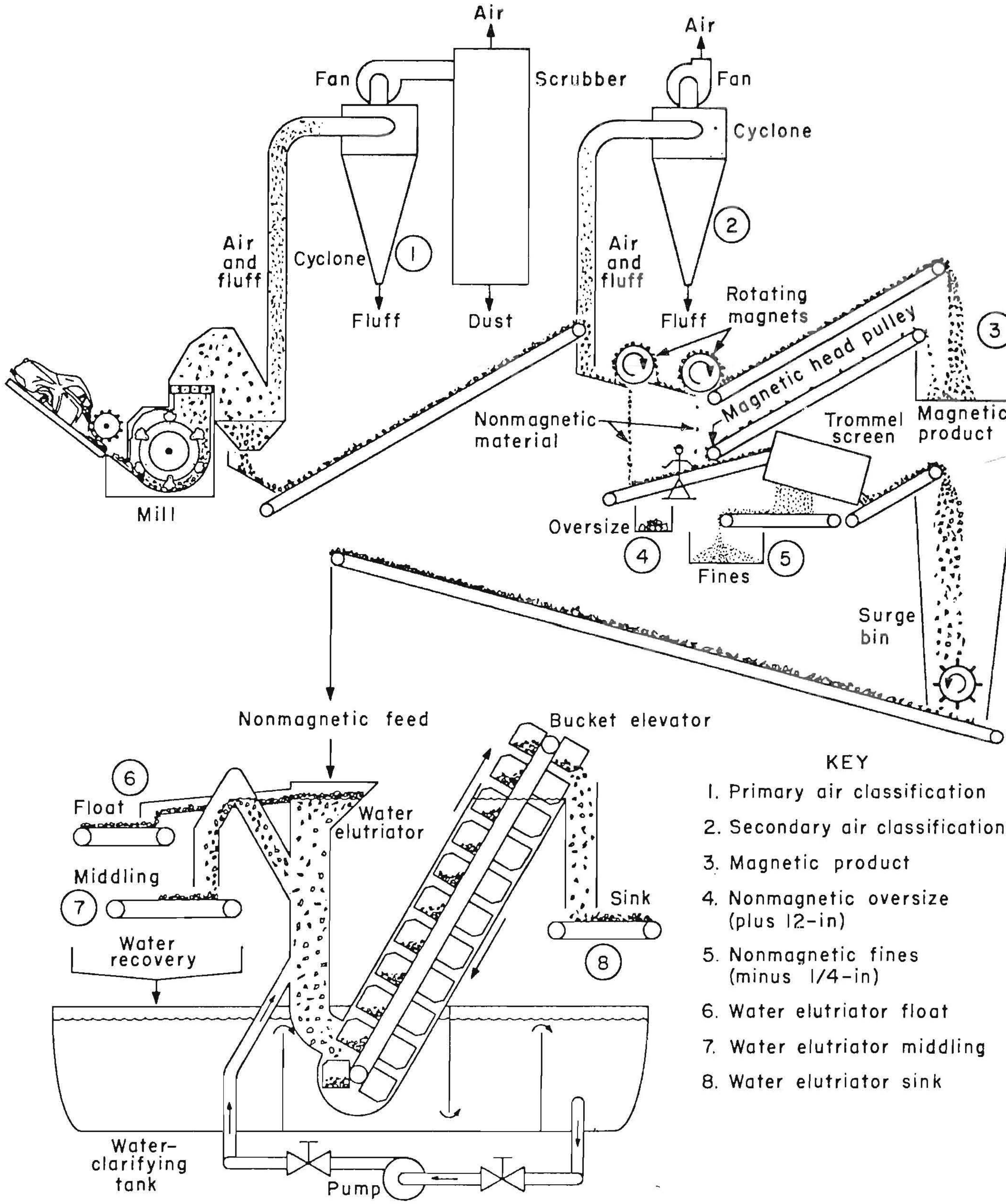


FIGURE 9. - Diagram of shredding and processing operation showing product and reject collection areas.

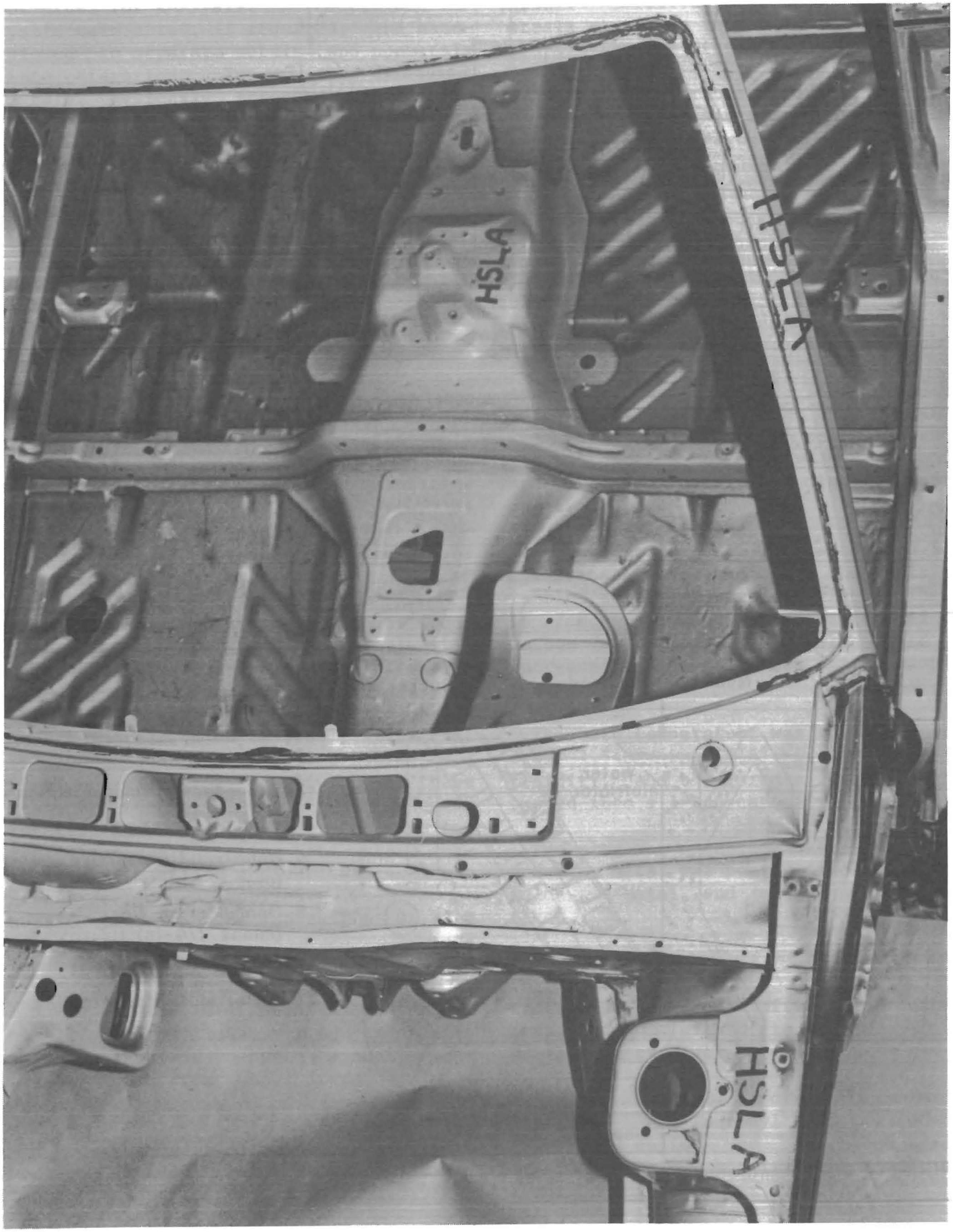


FIGURE 10. - HSLA steel application in 1982 Nissan Sentra.

Datsun.--Three 1981 Datsun 210 models, two-door hatchback coupes. Deluxe equipment package; four-cylinder, 1,500-cm^3 engines and five-speed manual transmissions.

Sentra.--Three 1982 Nissan Sentra models, including two standard and one deluxe two-door sedans; four-cylinder, 1,500-cm^3 engines; five-speed manual transmissions and front-wheel drive.

RESULTS

HAND DISMANTLING

Table 1 gives weights of the automobiles as received and as prepared for dismantling.

The completed hand dismantling study shows (see table 2) that the four models of Japanese automobiles averaged, in pounds:

Ferrous metals	1,472.9
Nonferrous metals	115.6
Combustibles	275.2
Noncombustibles	72.3
Electrical components	2.3
Total	1,938.3

Light iron (<1/8 in thick) was the largest single weight category in all of the bodies. The heavier ferrous metals were concentrated in the engines, transmissions, drive trains, and suspensions. The ferrous metals comprised an average 76 pct of the automobiles' weight.

The nonferrous metal contents of the dismantled automobiles averaged, in pounds--

Aluminum	84.6
Copper and brass	24.8
Zinc diecast	5.3
Lead	.9
Total	115.6

Nonferrous metals averaged 6 pct of the automobiles' weight. Aluminum comprised over 73 pct of the nonferrous metals weight and was concentrated in the engines and transmissions. The Toyota Tercel also had aluminum wheels. Copper and brass were concentrated in dashboard and engine compartments as wiring and electrical components; however, they were found in smaller quantities throughout the entire automobile. The Honda Accord contained the greatest percentage of zinc diecast, mostly as knobs and switches with only minor engine usage. Lead tire weights were on all the automobiles.

Rubber and plastics were the primary combustibles. Glass was the major noncombustible.

Spectrographic analysis of the electronic components removed from the four automobiles as analyzed at the Avondale Research Center showed gold, silver, and palladium as alloying elements or trace contents. Indium was detected in several of the flasher units in the Datsun 210, which also contained more precious metals than the other automobiles. Soldered connections accounted for most of the silver detected.

TABLE 1. - Weights of the four Japanese automobiles as received and as prepared for hand dismantling, pounds

	Honda	Toyota	Datsun	Nissan
As received	2,183	2,000	2,010	1,975
Removed before dismantling:				
Coolant	10	11.9	12.1	15.1
Oil and grease	14	12.3	12.2	17.0
Gasoline	3.3	22.4	59.8	68.3
Battery	36	28.4	35.1	34.2
Tools and lift	7	4.6	5.4	5.7
Total	70.3	79.6	124.6	140.3
To be dismantled	2,112.7	1,920.4	1,885.4	1,834.7

TABLE 2. - Materials contained in four Japanese automobiles as determined by hand dismantling

Class of material	1981 Honda Accord		1981 Toyota Tercel		1981 Datsun 210		1982 Nissan Sentra		Combined average	
	lb	pct	lb	pct	lb	pct	lb	pct	lb	pct
Ferrous:										
Light iron.......	1,079.6	51.1	958.1	49.9	754.2	40.0	671.6	36.6	865.9	44.7
HSLA steel.......	0	0	0	0	0	0	169.3	9.2	42.3	2.2
Galvanized iron..	0	0	.1	0	19.2	1.0	6.8	.4	6.5	.3
Chrome-plated steel...........	24.8	1.2	6.7	.4	31.1	1.6	2.6	.2	16.3	.8
Copper-coated iron............	.1	0	.1	0	0	0	.2	0	.1	0
Spring steel.....	30.1	1.4	36.5	1.9	39.5	2.1	25.8	1.4	33.0	1.7
Steelplate.......	183.3	8.7	84.0	4.3	277.5	14.7	201.5	11.0	186.6	9.6
Hardened steel...	85.2	4.0	91.0	4.7	135.3	7.2	50.0	2.7	90.4	4.7
Cast iron........	128.0	6.1	101.7	5.3	146.4	7.8	113.5	6.2	122.4	6.3
Cast steel.......	92.9	4.4	104.7	5.5	54.0	2.9	139.8	7.6	97.8	5.1
Stainless steel..	13.2	.6	13.7	.7	13.9	.7	5.7	.3	11.6	.6
Subtotal......	1,637.2	77.5	1,396.6	72.7	1,471.1	78.0	1,386.8	75.6	1,472.9	76.0
Nonferrous:										
Aluminum.........	67.7	3.2	[1]141.5	7.4	52.5	2.8	76.7	4.2	84.6	4.4
Zinc.............	10.8	.5	5.4	.3	2.0	.1	2.9	.2	5.3	.3
Lead[2]...........	1.2	.1	.6	0	.9	0	.9	0	.9	0
Copper and brass.	19.9	1.0	19.5	1.0	18.9	1.0	17.4	1.0	18.9	1.0
Copper (wire)[3]...	7.2	.3	5.0	.3	5.1	.3	6.4	.3	5.9	.3
Subtotal......	106.8	5.1	172.0	9.0	79.4	4.2	104.3	5.7	115.6	6.0
Combustibles:										
Plastic (wire)[3]..	4.8	.2	3.3	.1	3.3	.2	4.2	.2	3.9	.2
Polyurethane foam	22.7	1.1	24.4	1.3	19.6	1.1	22.7	1.2	22.3	1.2
Vinyl............	13.4	.6	14.0	.7	13.9	.7	8.8	.5	12.5	.6
Other plastics...	82.5	3.9	75.1	3.9	64.8	3.4	67.0	3.7	72.4	3.8
Rubber[4]..........	144.7	6.9	101.3	5.3	103.2	5.5	117.3	6.4	116.6	6.0
Carbon...........	.6	0	1.8	.1	.7	0	.7	0	1.0	0
Other combustibles....	32.3	1.5	45.2	2.4	52.2	2.8	56.2	3.1	46.5	2.4
Subtotal......	301.0	14.2	265.1	13.8	257.7	13.7	276.9	15.1	275.2	14.2
Noncombustibles:										
Ceramics.........	2.9	.1	4.8	.2	3.3	.2	4.0	.2	3.8	.1
Glass............	63.0	3.0	80.0	4.2	68.6	3.6	57.8	3.1	67.3	3.5
Asbestos.........	1.2	.1	1.5	.1	1.1	.1	1.1	.1	1.2	.1
Subtotal......	67.1	3.2	86.3	4.5	73.0	3.9	62.9	3.4	72.3	3.7
Electric components[5].......	.6	0	.4	Trace	4.2	.2	3.8	.2	2.3	.1
Total.........	2,112.7	100.0	1,920.4	100.0	1,885.4	100.0	1,834.7	100.0	1,938.3	100.0

[1]The high aluminum content of the Toyota is attributed to aluminum wheels.
[2]Excluding batteries, which were not used in composition calculations.
[3]The plastic-coated wire was stripped to obtain a 60 copper-40 coating weight ratio.
[4]The steel-belted radial tires were weighed as rubber; however, they can contain up to 30 pct steel wire.
[5]Electrical components such as circuit boards and relays were weighed as single units and forwarded to the Bureau of Mines Avondale Research Center for precious metal identification.

SHREDDING

Collected shredded products and rejects from each pair of shredded automobiles varied in total weight from a 6.0-pct loss to a 9.2-pct gain of the prepared automobile weights, as shown in the shredded materials distribution in table 3. Losses and gains in weights are common in batch-type operations of the shredding process.

The distribution of products and rejects from processing shredded automobiles followed the typical pattern. The air classification systems collected most of the combustibles, and magnetic separation removed most of the iron. The fines collected from screening the nonmagnetic material contained most of the noncombustibles. Screened nonmagnetics processed by water elutriation yielded a clean, mixed nonmagnetic metal sink product and two reject fractions. The float and middling reject fractions from water elutriation contained both combustibles and noncombustibles. Tables 4 through 7 show the analysis and weight distribution of the products and rejects from each of the shredded automobiles.

Data from table 8 show a ferrous metal recovery of 99.2 pct and a nonferrous metal recovery of 79 pct.

TABLE 3. - Material distribution of the collected products and rejects obtained from shredding and processing four Japanese automobiles

Shredder products and rejects	1981 Honda Accord	1981 Toyota Tercel	1981 Datsun 210	1982 Nissan Sentra	Average
Prepared weight to auto shredder..............lb..	1,900	1,670	1,790	1,570	1,732.5
Combined recovered weight................lb..	1,785.9	[1]1,822.8	[1]1,712.3	[1]1,579.1	1,725.0
Primary air classification.......pct..	6.2	11.6	8.2	6.2	8.0
Secondary air classification.......pct..	5.5	7.3	5.1	4.9	5.7
Magnetic product......pct..	73.2	78.7	73.4	76.7	75.4
Nonmagnetic oversize..pct..	.2	.2	.6	[2]5.5	[3]3.4
Nonmagnetic fines.....pct..	2.0	3.2	2.4	([2])	([3])
Water elutriator, pct:					
Float.....................	2.5	1.6	1.4	.2	1.5
Middling..................	[4]Trace	1.5	1.2	1.2	.9
Sink......................	4.4	5.1	3.4	6.0	4.7
Total............pct..	94.0	109.2	95.7	100.7	99.6
Material balance......pct..	-6.0	+9.2	-4.3	+.7	-.4

[1]Weight gains are attributed to materials missed when the system was purged prior to shredding the cars.

[2]A tertiary air classifier was substituted for screen sizing for the Nissan Sentra processing; rejects were collected as 1 unit.

[3]Average is for the combined oversize and fines from all automobiles, as air classifying the Sentra distorted the results.

[4]The minimal amount of middling product collected from processing the Hondas was combined with the float product.

TABLE 4. - Analysis and weight distribution of metal products and rejects obtained from shredding a 1981 Honda Accord automobile,[1] pounds

Class of material	Metal products		Rejects					Combined totals
	Magnetic	Nonmagnetic	Primary air	Secondary air	Nonmagnetic oversize (>12 in)	Minus 1/2-in fines	Water elutriator float and middling	
Ferrous:								
Light iron..........	901.2	0.6	5.0	1.9	0	0.4	Trace	909.1
Chrome-plated steel.	.7	0	0	0	0	0	0	.7
Spring steel........	30.3	Trace	.3	.2	0	.7	Trace	31.5
Steelplate..........	270.0	3.3	9.9	0	0	0	0	283.2
Hardened steel......	ND	ND	ND	ND	ND	ND	ND	ND
Cast iron...........	155.7	8.5	0	1.8	0	1.7	Trace	167.7
Cast steel..........	ND	ND	ND	ND	ND	ND	ND	ND
Stainless steel.....	2.2	6.3	.1	.4	0	Trace	Trace	9.0
Minus 1/4 in........	9.7	0	0	0	0	0	0	9.7
Subtotal.........	1,369.8	18.7	15.3	4.3	0	2.8	Trace	1,410.9
Nonferrous:								
Aluminum............	2.1	41.9	.3	.3	0	4.0	.2	48.8
Zinc................	0	5.1	0	0	0	.1	Trace	5.2
Lead................	0	.1	0	0	0	Trace	Trace	.1
Copper and brass....	4.4	8.9	.1	.2	0	1.2	.3	15.1
Copper-coated wire[2].	1.2	2.3	.6	.6	0	.3	2.0	7.0
Subtotal.........	7.7	58.3	1.0	1.1	0	5.6	2.5	76.2
Combustibles:								
Polyurethane foam...	.1	Trace	13.2	7.5	0	.2	3.4	24.4
Vinyl...............	2.8	0	3.6	4.0	0	Trace	2.0	12.4
Other plastics......	.5	.7	6.0	14.2	1.6	3.6	23.8	50.4
Rubber..............	6.2	5.5	2.8	1.7	1.7	1.0	11.9	30.8
Other combustibles..	3.0	.1	40.4	30.8	0	2.8	4.2	81.3
Subtotal.........	12.6	6.3	66.0	58.2	3.3	7.6	45.3	199.3
Noncombustibles:								
Glass...............	0	.2	0	0	0	.1	.2	.5
Asbestos............	0	0	0	0	0	0	0	0
Subtotal.........	0	.2	0	0	0	.1	.2	.5
Nonmagnetic:								
Minus 1/4 in........	0	.2	34.8	40.9	0	22.6	.5	99.0
Total............	1,390.1	83.7	117.1	104.5	3.3	38.7	48.5	1,785.9

ND Not determined.

[1] 2 Honda Accords were shredded. The data shown have been adjusted to represent 1 automobile.

[2] Average analysis for coated copper wire: 60 pct copper, 40 pct coating.

TABLE 5. - Analysis and weight distribution of metal products and rejects obtained from shredding a 1981 Toyota Tercel automobile,[1] pounds

Class of material	Metal products		Rejects						Combined totals
	Magnetic	Nonmagnetic	Primary air	Secondary air	Nonmagnetic oversize (>12 in)	Minus 1/2-in fines	Water elutriator float	Water elutriator middling	
Ferrous:									
Light iron.........	812.9	1.8	3.9	0.3	0	<0.1	0.6	0.1	819.7
Chrome-plated steel	4.9	0	0	Trace	0	.1	0	0	5.0
Spring steel.......	35.0	0	.3	.3	0	<.1	0	0	35.7
Steelplate.........	154.7	0	.2	0	0	0	0	0	154.9
Hardened steel.....	58.1	0	.2	0	0	.2	0	0	58.5
Cast iron..........	77.8	0	.6	0	0	.4	0	0	78.8
Cast steel.........	120.2	0	0	0	0	0	0	0	120.2
Stainless steel....	2.3	2.5	0	Trace	0	.2	Trace	Trace	5.0
Minus 1/4 in.......	35.3	0	0	0	0	0	0	0	35.3
Subtotal........	1,301.2	4.3	5.2	.6	0	1.1	.6	.1	1,313.1
Nonferrous:									
Aluminum...........	2.0	61.7	<.1	.1	0	2.9	.2	.4	67.4
Zinc...............	0	2.9	0	0	0	<.1	0	0	3.0
Lead...............	0	.2	0	0	0	0	0	0	.2
Copper and brass...	1.9	11.7	<.1	.1	.8	1.2	<.1	.3	16.2
Coated-copper wire[2]	1.3	.7	.1	.3	0	.3	1.1	1.3	5.1
Subtotal........	5.2	77.2	.3	.5	.8	4.5	1.4	2.0	91.9
Combustibles:									
Polyurethane foam..	.4	0	([3])	([3])	0	0	1.7	Trace	2.1
Vinyl..............	1.4	0	([3])	([3])	0	0	1.5	.1	3.0
Other plastics.....	.2	.9	([3])	([3])	1.1	7.0	13.6	5.3	28.1
Rubber.............	2.8	2.6	([3])	([3])	1.3	1.0	6.1	15.6	29.4
Other combustibles.	.9	.3	87.6	62.5	0	2.6	1.6	1.0	156.5
Subtotal........	5.7	3.8	87.6	62.5	2.4	10.6	24.5	22.0	219.1
Noncombustibles:									
Glass..............	Trace	Trace	Trace	.1	0	1.5	0	Trace	1.6
Asbestos...........	0	0	0	0	0	0	0	0	0
Subtotal........	Trace	Trace	Trace	.1	0	1.5	0	Trace	1.6
Nonmagnetic:									
Minus 1/4 in.......	2.2	.1	100.8	57.4	0	35.3	.8	.5	197.1
Total..........	1,314.3	85.4	193.9	121.1	3.2	53.0	27.3	24.6	1,822.8

[1]2 Toyota Tercels were shredded. The data shown have been adjusted to represent 1 automobile.
[2]Average analysis for coated copper wire: 60 pct copper, 40 pct coating.
[3]Combined with other combustibles.

TABLE 6. - Analysis and weight distribution of metal products and rejects obtained from shredding a 1981 Datsun 210 automobile,[1] pounds

Class of material	Metal products		Rejects						Combined totals
	Magnetic	Nonmagnetic	Primary air	Secondary air	Nonmagnetic oversize (>12 in)	Minus 1/2-in fines	Water elutriator float	Water elutriator middling	
Ferrous:									
Light iron	690.7	2.2	4.1	0.6	1.2	1.3	0.6	0.2	700.9
Chrome-plated steel	17.9	0	0	0	0	0	0	0	17.9
Spring steel	32.6	1.1	.2	.1	.1	Trace	Trace	.1	34.2
Heavy iron	254.8	.2	0	0	0	0	0	0	255.0
Hardened steel	60.4	.8	Trace	0	0	.2	0	0	61.4
Cast iron	113.4	1.6	.5	0	0	0	0	0	115.5
Cast steel	93.2	.2	0	0	0	0	0	0	93.4
Stainless steel	6.8	2.3	.4	Trace	0	.2	0	Trace	9.7
Minus 1/4 in	17.0	0	0	0	0	0	0	0	17.0
Subtotal	1,286.8	8.4	5.2	.7	1.3	1.7	.6	.3	1,305.0
Nonferrous:									
Aluminum	4.7	31.1	.3	Trace	0	1.6	.2	.4	38.3
Zinc	1.7	6.0	0	0	0	.3	0	0	8.0
Lead	0	.1	0	0	0	0	0	0	.1
Copper and brass	2.5	5.6	.1	.2	2.1	.5	.4	.3	11.7
Coated copper wire[2]	1.9	.9	.5	.5	Trace	.2	2.9	.9	7.8
Subtotal	10.8	43.7	.9	.7	2.1	2.6	3.5	1.6	65.9
Combustibles:									
Polyurethane foam	.6	0	([3])	([3])	.2	0	1.5	0	2.3
Vinyl	2.8	0	([3])	([3])	1.2	0	2.1	.8	6.9
Other plastics	1.7	1.0	([3])	([3])	3.8	3.2	9.0	5.5	24.2
Rubber	5.3	7.0	([3])	([3])	2.7	.7	3.7	9.8	29.2
Other combustibles	3.9	.2	99.5	52.0	.1	.6	2.7	2.4	161.4
Subtotal	14.3	8.2	99.5	52.0	8.0	4.5	19.0	18.5	224.0
Noncombustibles:									
Glass	0	.4	0	.1	0	.2	.9	.2	1.8
Asbestos	0	0	0	0	0	0	0	0	0
Subtotal	0	.4	0	.1	0	.2	.9	.2	1.8
Nonmagnetic:									
Minus 1/4 in	1.8	.1	41.1	36.8	0	33.2	1.7	.9	115.6
Total	1,313.7	60.8	146.7	90.3	11.4	42.2	25.7	21.5	1,712.3

[1]2 Datsun 210's were shredded. The data shown have been adjusted to represent 1 automobile.
[2]Average analysis for coated copper wire: 60 pct copper, 40 pct coating.
[3]Combined with other combustibles.

TABLE 7. - Analysis and weight distribution of metal products and rejects obtained from shredding a 1982 Nissan Sentra automobile,[1] pounds

Class of material	Metal products		Rejects					Combined totals
	Magnetic	Nonmagnetic	Primary air	Secondary air	Tertiary air[2]	Water elutriator float	Water elutriator middling	
Ferrous:								
Light iron	765.1	0.7	0.6	0.1	0	0	Trace	766.5
Chrome-plated steel	1.3	0	.1	Trace	0	0	0	1.4
Spring steel	35.6	.1	Trace	.2	Trace	0	0	35.9
Steelplate	153.2	0	0	0	0	0	0	153.2
Hardened steel	17.9	0	0	0	0	0	0	17.9
Cast iron	104.3	.2	Trace	0	0	0	Trace	104.5
Cast steel	93.8	0	0	0	0	0	0	93.8
Stainless steel	1.6	2.6	Trace	.1	.4	Trace	Trace	4.7
Minus 1/4 in	9.0	0	0	0	0	0	0	9.0
Subtotal	1,181.8	3.6	.7	.4	.4	Trace	Trace	1,186.9
Nonferrous:								
Aluminum	5.1	63.1	.2	.2	.3	.1	.4	69.4
Zinc	0	2.2	Trace	Trace	Trace	0	Trace	2.2
Lead	0	.5	0	0	0	0	0	.5
Copper and brass	2.9	12.1	.2	.2	1.4	Trace	Trace	16.8
Coated copper wire[3]	2.0	.6	.2	.4	5.0	Trace	.2	8.4
Subtotal	10.0	78.5	.6	.8	6.7	.1	.6	97.3
Combustibles:								
Polyurethane foam	.6	0	(4)	(4)	1.1	Trace	Trace	1.7
Vinyl	1.6	0	(4)	(4)	2.4	0	Trace	4.0
Other plastics	2.9	.3	(4)	(4)	27.6	.8	1.1	32.7
Rubber	4.6	4.9	(4)	(4)	9.3	1.7	14.7	35.2
Other combustibles	1.7	.6	73.7	49.5	5.5	.3	1.7	133.0
Subtotal	11.4	5.8	73.7	49.5	45.9	2.8	17.5	206.6
Noncombustibles:								
Ceramics	.3	0	0	0	0	0	0	.3
Glass	.1	.1	.1	.2	1.7	0	.1	2.3
Asbestos	0	0	0	Trace	0	0	0	Trace
Subtotal	.4	.1	.1	.2	1.7	0	.1	2.6
Nonmagnetic:								
Minus 1/4 in	0	6.7	20.1	26.4	32.1	.1	.3	85.7
Total	1,203.6	94.7	95.2	77.3	86.8	3.0	18.5	1,579.1

[1]2 Nissan Sentras were shredded. The data shown have been adjusted to represent 1 automobile.
[2]Fines and oversize were not removed by screening. A 3d air classification was used.
[3]Average analysis for coated copper wire: 60 pct copper, 40 pct coating.
[4]Combined with other combustibles.

TABLE 8. - Metals recovered compared with total metals contained in the magnetic and nonmagnetic shredded products of Japanese automobiles[1]

Metals	Total metals collected, lb	Recovered metals,[2] lb	Shredded metal recovery versus collected shredded metals, pct
Ferrous metals	1,304.0	1,293.7	99.2
Nonferrous metals:			
Aluminum	56.0	49.4	88.2
Zinc	4.6	4.1	89.1
Lead	.2	.1	50.0
Copper and brass	15.0	9.6	64.0
Copper (coated wire)	4.2	0	0
Subtotal	80.0	63.2	79.0
Total	1,384.0	1,356.9	98.0

[1]The metal weights shown are average weights from the combined automobiles.

[2]Recovered metals are collected in the magnetic and elutriated products. Nonferrous metals in the collected magnetic product and copper from coated wire were not recovered.

COMPARISON OF RECOVERED SHREDDED PRODUCTS AND HAND-DISMANTLED AUTOMOBILE CONTENTS

The Japanese automobiles contained a greater percentage of light gage steel than the previously dismantled automobiles (4), and the Sentra contained a significant amount of HSLA steel. The Japanese automobiles also contained a significantly higher percentage of aluminum, which comprised more than 73 pct of the nonferrous metal content. Tables 9 and 10 compare the materials collected from shredded automobiles with the corresponding materials in the dismantled automobiles. Metal losses after shredding were noted in both the ferrous and nonferrous metal categories, with some inconsistencies in the ferrous metal category when compared to the dismantling data. These were attributed to difficulties in identification of the shredded metals, which are discolored, squeezed together, and often not separable.

Apparent metal losses in material hangups occurred throughout the system when shredding only two automobiles at a time without purging the entire shredding system after processing the cars. The losses appear excessive, but during operation the system is continuously purging so the losses would become insignificant compared to the total throughput. Other losses were attributed to brittle metals such as cast iron, aluminum, and zinc diecast, which shattered and were lost to the fines, were removed as dirt in the air collection system, or became part of the sludge in the elutriation system.

The combustibles showed little difference between the dismantled contents and the shredded rejects. There were differences in noncombustibles because glass from the shredded automobiles was collected in the minus 1/4-in rejects, which were not analyzed.

An averaged weight comparison of the metals recovered with the total metals contained in the shredded magnetic and nonmagnetic products is shown in table 8. A similar weight comparison of the averaged metals recovered from shredded automobiles with the metal content of similar dismantled automobiles is presented in table 11.

Metal recovery based upon the total collected shredded materials averaged 99.2 pct for ferrous and 79.0 pct for nonferrous metals. Compared to the dismantled automobile weights, the averaged recoveries were 93.1 pct for the ferrous metals and 62.2 pct for the nonferrous metals.

TABLE 9. - Comparison of materials determined by hand dismantling and collected from shredding the Honda and Toyota automobiles[1]

Class of material	1981 Honda Accord				1981 Toyota Tercel			
	Dismantled		Shredded		Dismantled		Shredded	
	lb	pct	lb	pct	lb	pct	lb	pct
Ferrous:								
Light iron	1,054.9	54.3	909.1	50.9	939.1	52.4	819.7	45.0
Galvanized iron	0	0	0	0	.1	Trace	0	0
Copper-coated iron	.1	0	0	0	6.7	.4	0	0
Chrome-plated steel	24.8	1.3	.7	Trace	.1	Trace	5.0	.3
Spring steel	30.1	1.6	31.5	1.8	36.4	2.0	35.7	2.0
Steelplate	181.2	9.3	283.2	15.9	69.2	3.9	154.9	8.5
Hardened steel	ND	ND	ND	ND	91.0	5.1	58.5	3.2
Cast iron	128.0	6.6	167.7	9.4	101.7	5.7	78.8	4.3
Cast steel	92.9	4.8	ND	ND	104.7	5.8	120.2	6.6
Stainless steel	13.2	.7	9.0	.5	13.7	.8	5.0	.3
Minus 1/4 in	0	0	9.7	.5	0	0	35.3	1.9
Subtotal	1,525.2	78.6	1,410.9	79.0	1,362.7	76.1	1,313.1	72.1
Nonferrous:								
Aluminum	67.7	3.5	48.8	2.7	87.5	4.9	67.4	3.7
Zinc	10.8	.6	5.2	.3	5.4	.3	3.0	.1
Lead	.6	Trace	.1	Trace	.4	Trace	.2	Trace
Copper and brass	19.9	1.0	15.1	.9	19.4	1.1	16.2	.9
Copper (coated wire)	7.2	.4	4.2	.2	5.0	.3	3.1	.2
Subtotal	106.2	5.5	73.4	4.1	117.7	6.6	89.9	4.9
Combustibles:								
Plastic (coated wire)	4.8	.3	2.8	.2	3.3	.2	2.0	.1
Polyurethane foam	22.7	1.2	24.4	1.4	24.4	1.4	2.1	.1
Vinyl	13.4	.7	12.4	.7	14.0	.8	3.0	.2
Other plastics	82.5	4.2	50.4	2.8	74.7	4.2	28.1	1.5
Rubber	62.2	3.2	30.8	1.7	36.4	2.0	29.4	1.6
Carbon	.6	Trace	0	0	1.8	.1	0	0
Other combustibles	32.9	1.7	81.3	4.6	45.6	2.5	[2]156.5	8.6
Subtotal	219.1	11.3	202.1	11.4	200.2	11.2	221.1	12.1
Noncombustibles:								
Ceramics	2.9	.1	0	0	4.8	.2	0	0
Glass	63.0	3.2	.5	Trace	80.0	4.5	1.6	.1
Asbestos	1.2	.1	0	0	1.5	.1	0	0
Subtotal	67.1	3.4	.5	Trace	86.3	4.8	1.6	.1
Nonmagnetic:								
Minus 1/4 in	0	0	99.0	5.5	0	0	197.1	10.8
Fluids	24.2	1.2	ND	ND	24.2	1.3	ND	ND
Total	1,941.8	100.0	1,785.9	100.0	1,791.1	100.0	1,822.8	100.0

ND Not determined separately--included with steelplate.
[1]The weights of the shredded materials are representative of 1 automobile.
[2]Includes the weight of all combustibles from the air classification systems.

TABLE 10. - Comparison of materials determined by hand dismantling and collected from shredding the Datsun and Sentra automobiles[1]

Class of material	1981 Datsun 210				1982 Nissan Sentra			
	Dismantled		Shredded		Dismantled		Shredded	
	lb	pct	lb	pct	lb	pct	lb	pct
Ferrous:								
Light iron	727.9	41.4	700.9	40.9	821.1	48.4	766.5	48.6
Galvanized iron	19.2	1.1	0	0	6.8	.4	0	0
Copper-coated iron	0	0	0	0	.2	Trace	0	0
Chrome-plated steel	31.1	1.8	17.9	1.1	2.6	.2	1.4	.1
Spring steel	39.5	2.3	34.2	2.0	25.8	1.5	35.9	2.3
Heavy iron	214.4	12.2	255.0	14.9	122.4	7.2	153.2	9.7
Hardened steel	135.3	7.7	61.4	3.6	50.0	3.0	17.9	1.1
Cast iron	146.4	8.3	115.5	6.6	113.5	6.7	104.5	6.6
Cast steel	54.0	3.1	93.4	5.5	139.8	8.2	93.8	5.9
Stainless steel	13.9	.8	9.7	.6	4.6	.3	4.7	.3
Minus 1/4 in	0	0	17.0	1.0	0	0	9.0	.6
Subtotal	1,381.7	78.7	1,305.0	76.2	1,286.8	75.9	1,186.9	75.2
Nonferrous:								
Aluminum	52.5	3.0	38.3	2.2	76.7	4.5	69.4	4.4
Zinc	2.0	.1	8.0	.5	2.9	.2	2.2	.1
Lead	.9	.1	.1	Trace	Trace	Trace	.5	Trace
Copper and brass	18.7	1.0	11.7	.7	17.4	1.0	16.8	1.1
Copper (coated wire)	5.1	.3	4.7	.3	6.4	.4	5.0	.3
Subtotal	79.2	4.5	62.8	3.7	103.4	6.1	93.9	5.9
Combustibles:								
Plastic (coated wire)	3.3	.2	3.1	.2	4.2	.3	3.4	.2
Polyurethane foam	19.6	1.1	2.3	.1	22.7	1.3	1.7	.1
Vinyl	13.9	.8	6.9	.4	8.8	.5	4.0	.3
Other plastics	64.8	3.7	24.2	1.4	67.0	4.0	32.7	2.1
Rubber	39.5	2.3	29.2	1.7	47.7	2.8	35.2	2.2
Carbon	.7	Trace	0	0	.7	Trace	0	0
Other combustibles	56.4	3.2	[2]161.4	9.4	60.0	3.5	[2]133.0	8.4
Subtotal	198.2	11.3	227.1	13.2	211.1	12.4	210.0	13.3
Noncombustibles:								
Ceramics	3.3	.1	0	0	4.0	.2	.3	0
Glass	68.6	3.9	1.8	.1	57.8	3.4	2.3	.2
Asbestos	1.1	.1	0	0	1.1	.1	Trace	Trace
Subtotal	73.0	4.1	1.8	.1	62.9	3.7	2.6	.2
Nonmagnetic:								
Minus 1/4 in	0	0	115.6	6.8	0	0	85.7	5.4
Fluids	24.3	1.4	ND	ND	32.0	1.9	ND	ND
Total	1,756.4	100.0	1,712.3	100.0	1,696.2	100.0	1,579.1	100.0

ND Not determined separately--included with steelplate.
[1]The weights of the shredded materials are representative of 1 automobile.
[2]Includes the weight of all combustibles from the air classification systems.

TABLE 11. -Metals recovered from shredded Japanese automobiles compared with metals contained in similar dismantled automobiles[1]

Metals	Dismantled metals, lb	Recovered shredded metals,[2] lb	Shredded metal recovery versus dismantled content, pct
Ferrous metals..........	[3]1,389.1	1,293.7	93.1
Nonferrous metals:			
Aluminum..............	71.1	49.4	69.5
Zinc..................	5.3	4.1	77.4
Lead..................	.5	.1	20.0
Copper and brass......	18.8	9.6	51.1
Copper (coated wire)..	5.9	0	0
Subtotal...........	101.6	63.2	62.2
Total..............	1,490.7	1,356.9	91.0

[1]The metal weights shown are averages from the combined automobiles.

[2]Recovered metals are collected in the magnetic and elutriated products. Nonferrous metals in the collected magnetic product and copper from coated wire were not recovered.

[3]The dismantled automobile weights excluded 79.5 lb and 13.3 lb of ferrous metals from the wheels and gas tanks, which are not shredded.

HIGH-STRENGTH LOW-ALLOY STEEL

HAND DISMANTLING

HSLA steel is contained throughout the "white body"[5] of the Sentra automobiles and constitutes, by weight of the metals, 33.1 pct of the two-door and 35.8 pct of the four-door sedan. The major portions are used in the doors, hood, and trunk lid, which are accessible for removal.

Structural and support applications throughout the body framework account for the remaining HSLA steel. The difficulty in identifying the HSLA steels and the welded construction of the unibody and components would deter practical hand recovery methods.

[5]A "white body" is a complete body including doors, hood, lid, etc., that is welded and fitted with no accessories. It is everything that is to be painted the color of the automobile.

RECYCLING

Meltdown of the magnetic product from one of the shredded Sentras at the Albany Research Center produced a steel with the following analysis (weight percent):

Al = <0.01	Ni = 0.064
C = 0.019	P = 0.033
Cr = 0.013	S = 0.019
Cu = 0.31	Si = <0.01
Mn = <0.01	Sn = <0.01
Mo = <0.01	V = <0.01

Addition of quartz and limestone to the furnace to form a suitable slag and FeMn addition to increase the carbon and manganese levels produced a melt having the following analysis (weight percent):

Al = 0.020	Ni = 0.072
C = 0.048	P = 0.041
Cr = 0.017	S = 0.024
Cu = 0.45	Si = <0.01
Mn = 0.040	Sn = 0.01
Mo = <0.01	V = <0.01

After 30 min, the melt was tapped, sampled, and analyzed. The analysis of the final steel product follows (weight percent):

Al = <0.01	Ni = 0.075
C = 0.021	P = 0.037
Cr = 0.018	S = 0.012
Cu = 0.39	Si = <0.01
Mo = <0.01	Sn = <0.01
Mn = <0.01	V = <0.01

The slag analysis (weight percent) was--

Al_2O_3 = 3.82	Mo = 0.001-0.01
B = 0.01-0.1	Ni = ND
C = ND	P = ND
CaO = 10.8	S = 0.034
Cr = 0.03-0.3	SiO_2 = 18.0
Cu = 0.001-0.01	Sn = ND
Fe = 51.0	Ti = 0.003-0.03
MgO = 0.91	V = 0.003-0.03
Mn = 0.03-0.3	(ND = Not detected)

In all three metal samples, elements not detected by spectrographic qualitative analysis were As, B, Ba, Be, Ca, Cb, Cd, Co, Hf, Mg, Na, Pb, Sb, Ta, Ti, W, Zn, and Zr.

The analysis represents a standard carbon steel that conforms to AISI grade 1005 and shows that a standard steel can be melted directly from this scrap material. Any number of steel compositions can be prepared therefrom with suitable alloy additions.

Spectrographic analyses demonstrated that undesirable tramp elements were not present at levels above our detection limits in any of the metal samples. This indicates that HSLA steel from these automobiles should not adversely affect the quality of ferrous products prepared therefrom.

CONCLUSIONS

The average weight of the four hand-dismantled Japanese automobiles was 1,938.3 lb, including 1,472.9 lb ferrous metals, 115.6 lb nonferrous metals, 275.2 lb combustibles, 72.3 lb noncombustibles, and 2.3 lb electrical components. The respective weight percents were 76.0 pct ferrous metals, 6.0 pct nonferrous metals, 14.2 pct combustibles, 3.7 pct noncombstibles, and 0.1 pct electronic components. Compared to previously dismantled circa 1960 U.S. automobiles, the four Japanese-manufactured automobiles were smaller and contained a lower percentage of ferrous metals, comparable nonferrous metals, and a higher percentage of nonmetals. More than 60 pct of the ferrous metals were light gage steel, including HSLA steel, and of the 6-pct nonferrous metal content, more than 73 pct was aluminum.

Shredding of the Japanese automobiles, less tires, fluids, tools, wheels, batteries, and gas tanks, yielded average ferrous metal recoveries of 1,293.7 lb and nonferrous metal recoveries of 63.2 lb per automobile. There was also 223.2 lb of reject materials to be landfilled. This calculated to 99.2 pct ferrous metal recovery based upon total collected products, or 93.9 pct recovery based upon the projected shredder input from dismantling data. The major difference in loss is attributed to material hangups in the shredding mill and transfer equipment, which would be ultimately recovered in continuous operation.

Nonferrous metal recovery from the shredded automobiles was 79 pct. There was an 8.2 pct nonferrous metal loss during magnetic separation which reported with the ferrous product, and 12.8 pct was lost in the combined rejects. The nonferrous metal loss from shredding is excessive, and continued emphasis on nonferrous metal recovery appears to be warranted. Automobile shredder rejects, presently landfilled, will be of future concern when shredding the smaller automobiles. There will be a one-third increase in the amount of rejects for landfill to maintain the current shredded ferrous scrap production.

The HSLA steels used in the manufacture of the Sentra automobile, which are 12.2 pct of the total ferrous metals content, appear to be amenable to steel and foundry usage in recycling ferrous scrap. Total separation of a HSLA steel product by hand dismantling or from the shredded automobile does not appear to be feasible. No materials used in the manufacture of the Japanese automobiles would pose problems in present recycling technology.

REFERENCES

1. Callahan, J. M., and R. Hartley, Jr. Why Japan's Ahead. Automotive Industries, March 1982, pp. 34-37.

2. Chindgren, C. J., K. Dean, and L. Peterson. Recovery of the Nonferrous Metals From Auto Shredder Rejects by Air Classification. BuMines TPR 31, 1971, 11 pp.

3. Steel, D. K., and J. Sterner. A Water Elutriation System for Recovering Nonmagnetic Metals From Automobile Shredder Rejects. BuMines RI 8771, 1983, 22 pp.

4. Dean, K. C., and J. W. Sterner. Dismantling a Typical Junk Automobile To Produce Quality Scrap. BuMines RI 7350, 1969, 17 pp.

INT.-BU.OF MINES,PGH.,PA. 27377